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Original Research Article

Ready-to-use devices for intraosseous injections (BIG) in the practice of Emergency Medical Teams in the city and county of Poznań – Primary survey

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ABSTRACT

Introduction: Intraosseous (i.o.) access using a bone injection gun (BIG) is an efficient alternative to intravenous access, ensuring rapid infusion of fluids and medications. Intraosseous access is achieved through a ready-to-use BIG device allows for the delivery of fluids at flow rates up to 125 mL/min, and for performing basic laboratory tests.

Aim: The aim of this paper was to assess the knowledge of and scope of application for ready-to-use BIG devices among the members of Emergency Medical Teams from the District Emergency Station in the city and county of Poznań.

Material and methods: The survey was carried out in March and April 2013. Survey results were analyzed using Statistica 10.0 software, Polish version (analysis of statistical significance with the χ^2 test and χ^2 test incorporating Yates' correction at $\alpha = 0.05$).

Results: Respondents had positive results regarding the use of BIG devices, which they had acquired during a number of specialist courses.

Discussion: Despite this fact, BIG devices are rarely used during rescue operations in the city and county of Poznań, Poland and most frequently used in situations when achieving intravenous access is impossible within times shorter than 1 minute.

Conclusions: The results also confirmed that BIG devices are available in operations carried out by the ambulance Emergency Medical Service.

1. Introduction

The procedure for intraosseous (i.o.) access was developed in the early 20th century. It was used in the 1920s and during World War II, which was confirmed by about 4000 reports prepared at that time.[1] Currently, the implementation of advanced life-saving operations is associated with many difficulties in the pre-hospital setting, when circumstances are unfavorable, weather conditions are harsh or the environment hostile. Establishing venous access is one of the major operations carried out in casualties with sudden

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circulatory arrest. It is particularly important in pediatric patients with life-threatening conditions when obtaining intravenous (i.v.) access is often very difficult due to anatomical reasons. Establishing i.v. access is also difficult in patients where more than 2 minutes have elapsed when attempting during cardiopulmonary resuscitation (CPR). In these cases i.o. access should be considered.[2]

Intraosseous access is established by making an injection directly into the bone marrow space using a specially designed device. This is an alternative measure for delivering drugs and fluids when access to the peripheral veins is difficult or impossible. Drugs delivered through i.o. infusion achieve plasma levels in a time comparable to drugs delivered through the i.v. route. The needle insertion and thus establishing contact with the bone marrow space takes only 20 seconds or so. With correctly established i.o. access a flow rate of up to 125 mL/min can be achieved. In addition, it allows for collecting specimens in laboratory tests, such as blood typing, gasometry, blood count, hemoglobin or electrolyte levels.[3,4]

Intraosseous access is usually established in the proximal part of the tibial bone (near the tibial tuberosity), or in the distal part, near the medial ankle. Other penetration sites used for injection include the humeral bone head, radial bone or femoral bone.[5] Intraosseous access is contraindicated in patients with fractures or other injuries at the potential penetration site, as well as those with symptoms of infection in this part of the body. There is always a risk of complications that may occur when establishing i.o. access. The most frequent complications include hematoma, inflammation and bone fractures. Intraosseous access should not last longer than 24 hours, and should be discontinued as soon as peripheral or central i.v. access has been established.

2. Aim

The aim of this paper is to assess the knowledge of and scope of application for ready-to-use BIG devices among members of Emergency Medical Teams (EMT) from the District Emergency Station in the city and county of Poznań, Poland. Such a study has never been carried out in Poznań so far.

3. Materials and methods

The survey was carried out in March and April 2013 among the members of the basic and specialist EMT operating within the system of Public Emergency Medicine in the city and county of Poznań. The survey was carried out based on an original questionnaire concerning the use of BIG devices in everyday practice during rescue operations.

Survey results were analyzed using Statistica 10.0 software, Polish version (analysis of statistical significance with the χ^2 test and χ^2 test incorporating Yates' correction at $\alpha = 0.05$).

3.1. *Characteristics of the study group*

The study group included 81 subjects (73% men, 27% women). In total, 47% of respondents were under 31 years of age, 36% were 31–40 years old, and 17% were over 40 years old. Most

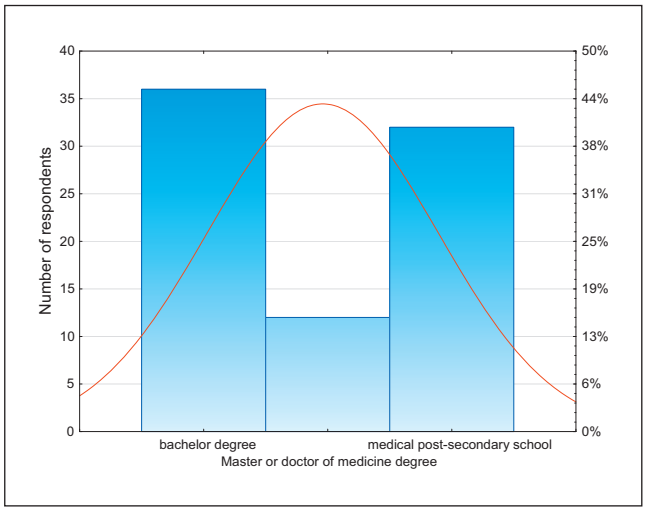

Fig. 1 – Education of respondents.

respondents were paramedics (80%), followed by subjects with an educational background in nursing (12%), and medical doctors (8%). With respect to the education of the EMT members, 46% of respondents had a bachelor degree, 39% had completed education in a medical post-secondary school, and 15% of respondents had a Master or doctor of medicine degree. Figure 1 presents the distribution of respondents by education, expressed in percent and number.

Most respondents (about 95%) worked in Wielkopolskie province. Respondents worked in cities with populations over 500 000 (35%), towns or cities with populations between 10 000 and 500 000 (50%), and only 15% worked in rural areas and small towns (up to 10 000 population); 22% of surveyed members of EMT had work experience longer than 4 years, 61% of respondents had experience between 5 and 10 years, and 17% had worked in their profession for longer than 10 years.

4. Results

All respondents had knowledge of BIG devices. In total, 51% of respondents declared to have access to BIG devices at all times when they were needed, 39% had a limited number of devices, 7% did not know if BIG devices were a part of ambulance equipment, and 3% declared that such devices were unavailable to them.

Respondents declared they acquire knowledge on establishing i.o. access from self-education (25%), specialist medical courses (e.g. ALS, ACLS, ITLS, PHTLS, EPLS, PASL) (23%), post-secondary school/higher degree studies (23%), in-house training organized by the employer (10%), or training received at more than one center (7%).

Figure 2 presents the distribution (in number and percentages) of the sources of knowledge on BIGs among respondents.

About 63% of all respondents (59% women and 64% of men) correctly indicated at least two sites for establishing i.o. access when presented with a diagram of the patient's body. There was no statistical correlation between the sex of EMT members and knowledge on the injection site for BIG ($P = 0.7095$).

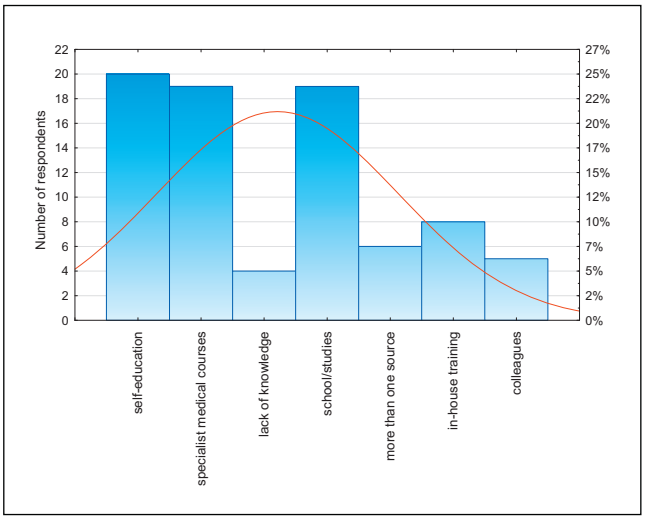

Fig. 2 – Source of knowledge on BIG devices.

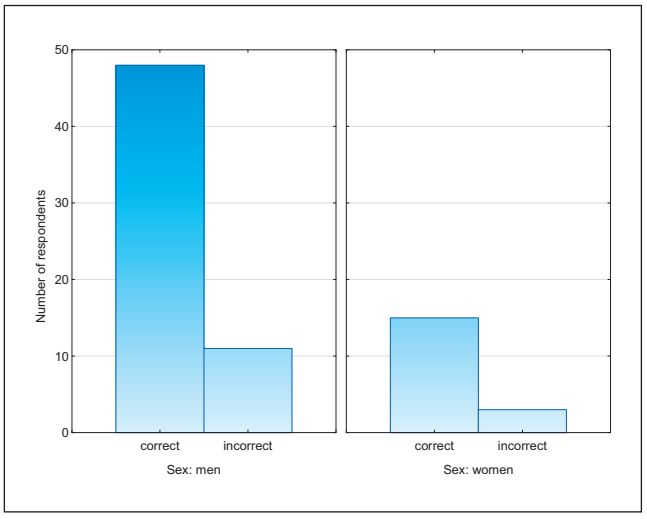

Fig. 4 – Recommended algorithm for the delivery of drugs during cardiopulmonary resuscitation – respondents' answers.

Respondents were also asked if they had had opportunity to see the procedure for establishing i.o. access in a casualty. About 60% of respondents had never seen this procedure done and 40% had seen it at least once. We found a statistically significant correlation between the sex and passive participation of the respondents in the use of an i.o. device ($P = 0.0197$). The percentage of men who had seen or had not seen the use of BIG during emergency operations was comparable (47% and 53%, respectively), versus 17% and 83% for women (Fig. 3).

There was no statistical correlation between the sex of EMT members and the use of a BIG device ($P = 0.3942$). During a 12-month period before the survey 73% of all respondents had not used the BIG device in emergency interventions, 26% had used BIG at least once (not more than five times within 12 months), and 1% had used BIG more than five times.

Another analyzed problem regarded the assessment of knowledge on the recommended algorithm for the delivery of drugs during cardiopulmonary resuscitation. According to the guidelines of the European Resuscitation Council (2010), the first-line access for the delivery of drugs should be i.v., then i.o., or via endotracheal tube as the last resort. The question about the algorithm was correctly answered by 82% of the surveyed members of EMT, and 18% indicated an incorrect order. We found no statistically significant difference between the respondents' sex and the current state of knowledge on the algorithm for the delivery of drugs ($P = 0.8739$) (Fig. 4).

Another survey question concerning the knowledge of the medical procedures that can be performed using the i.o. access, and 24% of EMT members indicated at least two procedures correctly. We found no statistical correlation between the respondents' sex and knowledge on procedures that can be performed using i.o. access ($P = 0.8805$).

Another question concerned knowledge on possible complications associated with i.o. injection, and 52% of respondents

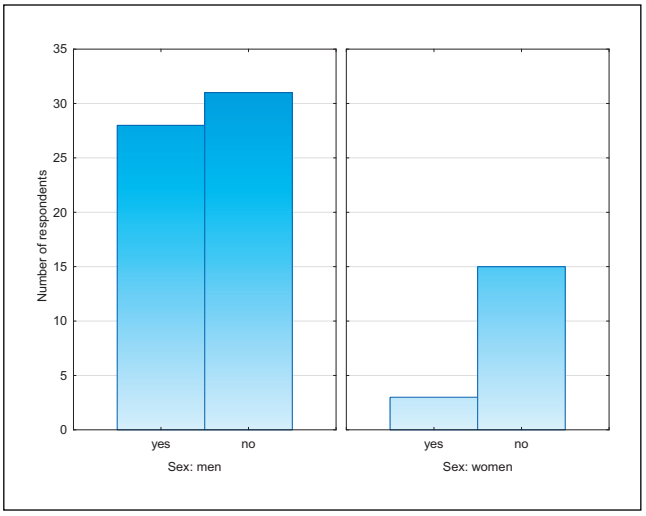

Fig. 3 – Passive participation during the use of BIG depending on the sex of respondents.

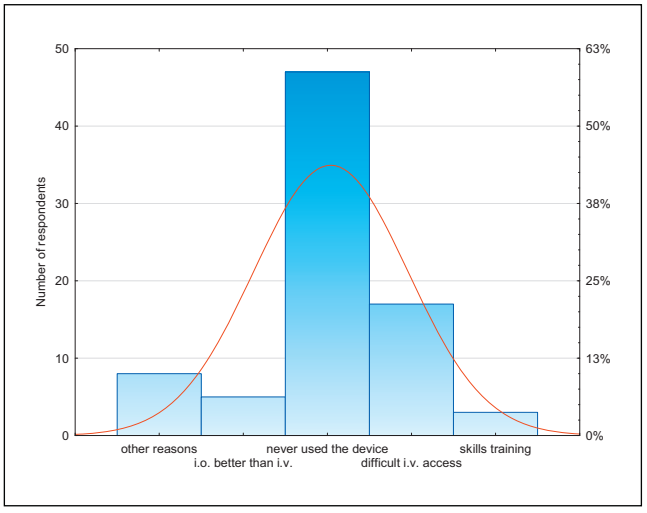

Fig. 5 – Reasons for the use of the BIG device declared by respondents.

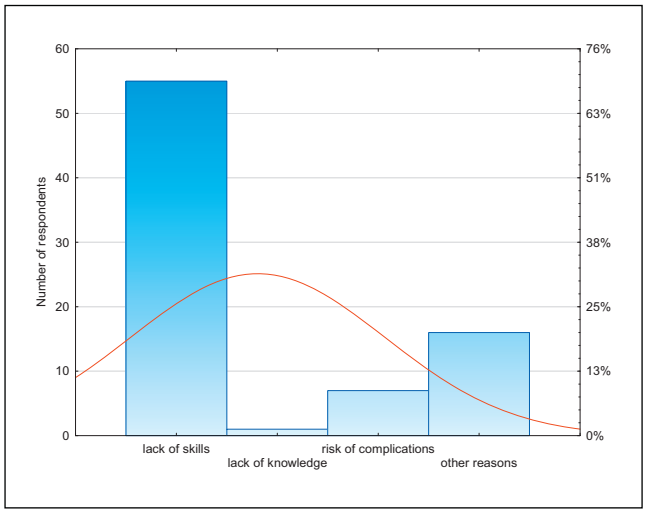

Fig. 6 – Reasons for not using i.o. access by respondents.

indicated at least two of these correctly. As with the previously analyzed problems, we found no statistical correlation between knowledge on complications associated with i.o. access and the respondent's sex ($P = 0.3740$).

Respondents indicated that the BIG device was used most frequently because of difficult i.v. access (21%), other reasons (10%), the need to save time through establishing i.o. access (6%), while 59% of all respondents declared that they had never used the device (Fig. 5).

Respondents asked about reasons for which i.o. devices were not used in their work indicated: lack of skills in establishing i.o. access caused by insufficient number of training hours (70%), risk of complications (9%), lack of knowledge on the procedure (1%) and other reasons (20%) (Fig. 6).

5. Discussion

In many life-threatening situations gaining rapid i.v. access is a factor determining proper therapy and adherence to the treatment plan. The role of ready-to-use i.o. devices available as a part of equipment to EMT is to improve significantly the possibility of i.v. access. Other studies carried out in 2010 by Olaussen and Williams from the School of Primary Health Care, University-Peninsula, Australia, demonstrated that gaining i.v. access is crucial in situations that require rapid drug administration.[6] This opinion was also reflected in the answers from respondents participating in our survey, who declared that unsuccessful attempts to establish correct vein cannulation caused the need for emergency i.o. intervention. In certain circumstances the use of semi-automatic or automatic devices for i.o. infusion is fully justified, particularly when medical staff are dealing with a challenging i.v. injection for a long time or which is impossible to perform. However, the lack of skills in establishing correct i.o. access may be problematic, especially in pediatric patients. This was confirmed by Isayama et al. from the Department of Emergency and Critical Care Medicine, Kansai Medical University, Osaka, Japan, who found in their study a significant number of complications associated with the use of devices for i.o. intervention in pediatric patients (1–7 years old).[2] The analysis of results from the surveyed group supported the findings from these reports and indicated that difficulties in establishing correct i.o. access are caused by insufficient experience in such types of intervention. On the other hand it was proven that establishing i.o. access requires much less time than i.v. access (less than 1 min), which is particularly important in trauma patients who need immediate delivery of fluids as a crucial element for the control of intensifying hypovolemic shock.[4]

The analysis of previously published scientific data indicates that i.o. interventions are fully justified in situations where traditional i.v. access is very difficult or impossible to achieve. The carried out survey indicated that despite free access to devices for i.o. injections, and the wide availability of educational courses on the use of BIG, a large group of EMT members (59%) do not use this equipment.

1. Most respondents (90%) declared that i.o. devices were available as a part of EMT equipment.
2. Most respondents acquired knowledge regarding the use of the BIG device through self-education, participation in specialist medical courses (ALS, ACLS, PHTLS, ITLS, PALS, EPLS), or they learned about i.o. access at the schools/universities where they acquired their professional license.
3. The most common reason for using BIG declared by the respondents was difficulty in establishing i.v. access in a short time (less than 1 min) and the need to ensure the immediate administration of life-saving medications.
4. The main reason for which i.o. devices were not used by EMT was the lack of skills in establishing i.o. access caused by an insufficient number of training hours at different levels of education.
5. Because of the high disproportion among the respondents regarding profession (80% were paramedics, but only 12% were nurses by education and 8% were medical doctors), it was impossible to carry out a comparative analysis for the skills in using BIG by these professional groups.

6. Conclusion

The BIG is an easy to use device, and because of that it has found applications in pre-hospital emergency medicine as an alternative to difficult or impossible to establish i.v. access in adult and pediatric patients. i.o. access as an option to achieve contact with the circulatory system was officially approved in guidelines by the European Resuscitation Council (ERC) in 2010 as a safe and efficient alternative to i.v. access.[3] Reports published in Poland and abroad confirmed the fact that i.o. devices are very good, and the only option to choose when i.v. access is difficult to achieve.

Establishing a venous line in patients with trauma or emergency life-threatening conditions is necessary to support the life and health of casualties. For this reason it is important for the members of EMT to have skills and confidence in using BIG devices in order to avoid wasting valuable time in unsuccessful attempts aimed at establishing i.v. access. Therefore, there is need to carry out intensive training covering the techniques, indications and use of the BIG in

different age groups of patients who require this type of intervention to be performed by medical staff working in the system of Public Emergency Medicine.

Conflict of interest

None declared.

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